

MOVEMENT OF HERBICIDE AND NUTRIENTS FROM FLATWOODS SITES INTO WETLANDS, AND THEIR IMPACTS ON WETLANDS BIOTA

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INTRODUCTION

One of the most important focal points in the interface between intensive land use and an ever-increasing population is water quality. Both intensive agriculture and forestry compete with an ever-increasing population for clean water. While this competition principally occurs throughout most of the eastern, gulf, and western seaboard, it is perhaps most evident in areas like Florida which are undergoing extraordinary population growth. Much of the deep-sand forested flatwoods of Florida serves as the recharge area for aquifers which provide this needed water. Surface water and surficial(perched) water tables from these areas are also being used for non-drinking needs including lawn and garden irrigation. With increased use of surface and perched water which arises from or flows through lands where intensive forestry is practiced, comes an increased potential for water contaminated with herbicides or nutrients to be used by downstream consumers. Thus it is very important to know to what extent these surface waters are contaminated by forestry practices. Concerns have also arisen over the potential for damage to aquatic ecosystems from forestry-related contaminated waters.

Concerns over the potential for contamination of perched water tables with herbicides used in forest management has led us to conduct several studies in Florida over the past 15 years. We have attempted to use sand-point wells in several studies with hexazinone (Velpar), sulfometuron (Oust), metsulfuron (Escort), and triclopyr (Garlon) which were designed to monitor potential herbicide contamination of surficial water tables in Florida. The results of these studies have been uniformly negative. These results are particularly difficult to accept considering results of studies on finer textured soils which uniformly identify movement of herbicides through soil profiles and into streams. It is possible that the sampling strategy used in the Florida studies was inadequate, and therefore results of the Florida studies may be in question.

The work described in this report includes 4 studies, either under way or planned, which will address the questions concerning forestry-related practices and their potential for water table and surface water contamination, and the impact of that contamination on wetland biota.

The studies are:

1. Water quality monitoring with sand-point wells. Objective: Identify effective sampling strategies for use with sand-point wells in water quality monitoring on forest sites.
2. Imazapyr half-life in wetland ponds and its toxicity to Chironomid species.
3. Movement of imazapyr from flatwoods sites into wetland ponds and impacts on the aquatic ecosystem.
4. Movement of nutrients from fertilized flatwoods sites into wetland ponds and impacts on the aquatic ecosystem.

Studies 1 and 2 are underway and will be described in more detail below. Study 3 will be conducted in 1998 and study 4 will follow in 1999. All studies will be conducted in the southeast block (clearcut) of the wetlands study site.

METHODS.

Study 1. Water quality monitoring with sand-point wells

Sand-point wells already on the site (Comerford et al. 1992) and associated with pond 20 were instrumented with Keller pressure transducers to measure well head, temperature probes, and dataloggers for the continuous monitoring of water table stage and temperature in the wells. Wells 13/-3, 14/-2, 14/-4, and 15/-3 provided information on water table response for upland sites and well 14/-3 provided information on pond level response over time. The wells will be referred to as WL1 (14/-2), WL2 (15/-3), WL3 (14/-4), WL4 (13/-3), and pond (14/-3) throughout this report. WL2 was also instrumented with an air-temperature probe and tipping-bucket rain gage which were continuously monitored by the data logger at WL2.

This sampling strategy study is designed to determine the most effective way to sample these wells. Currently two strategies are being tested. The method previously used involved evacuating the well and then taking a sample once the well had refilled. The first evacuation was discarded and the second retained for analysis. Sampling was usually conducted within 1 week after a storm event. In this study, samples are being retained from both evacuations for analysis. Because of the dynamics of the refill process a second method is being tested. The alternate method is designed to test the hypothesis that during refilling any analyte moving into the well from surface application may become so dilute as to make it undetectable with current analytical technology. Thus the alternate method being tested is to evacuate the well in thirds. The first evacuation, which previously has been discarded, is being kept producing 3 samples for analysis. Then after recharge, the well is evacuated again in thirds producing an additional 3 samples for analysis. All samples are analyzed to determine whether sampling strategy results in a difference in the amounts of analyte detected in the well. The most successful strategy will be employed in the imazapyr and fertilizer studies. Sampling was conducted within 1 week after each storm recorded on the site. In order to minimize the costliness of this study, KBr was applied at the rate of 0.6 kg/ha (0.5 lb/acre) and bromide analyzed with a Dionex ion chromatograph at a detection limit of 0.5 ppm.

2. Imazapyr half-life in wetland ponds and its toxicity to Chironomid species.

This study utilized 20 microcosms established in pond 23 (Riekerk et al. 1993). Schedule 40 PVC pipe was driven into the bottom of the test cypress dome to form microcosms which were 7.6 cm in diameter and contained a 30 cm column of water. Imazapyr in the form of Arsenal Applicator's Concentrate was added to these microcosms in sufficient quantity to yield a concentration which approximately 0 (control), 10, 100, and 1000 times the expected environmental concentration (EEC). The EEC is the concentration that should occur if this body

of water were directly over sprayed with the operational treatment rate for the surrounding forest site (0.56 kg ai/ha). The water column was mixed by gentle stirring and subsampled for 2 weeks following application. These water samples were analyzed for imazapyr concentration and the data used for half-life calculation.

Herbicide half-life was calculated from the herbicide residue data using the slope of simple linear regression line (log concentration vs time) for each matrix:

$$\text{Half-life} = -0.301/\text{slope}$$

Following the 2-week exposure period, the microcosms were removed along with the bottom material (cores) and analyzed for impacts on benthic macroinvertebrates. Cores were picked for benthic macroinvertebrates. Non-chironomids were identified to order or nearest possible taxonomic level. Chironomids were mounted on slides and speciated. Individuals in the genus *Chironomus* and *Procladius* were examined for mouth deformities in the mentum and ligula, respectively. These were classified as being deformed or not deformed, no scale of deformity was measured at this time.

The *Chironomus mentum* were not visible to identify deformities in two individuals from cores 2-3 and four individuals from core 7. These individuals were included in calculating abundance but not in percent deformity.

Cores 2 and 3 as well as cores 5 and 6 were combined by accident. Cores 2 and 3 were in the same treatment and kept in the analysis, while cores 5 and 6 were in different treatments and therefor excluded from the analysis.

RESULTS

Study 1. Water quality monitoring with sand-point wells

Well response to precipitation has been intensively monitored for the period of March 1997 to the present. Well stage response to even small precipitation events (2mm) is almost instantaneous. Well stage began to increase within 5-10 minutes of the beginning of precipitation and 80% of well response occurred within 5 minutes of maximum intensity for small, short-duration precipitation events. Stage response reflects the pore volume of the soil at each well. Well stage increased 37 times the incident precipitation (sd=6, N=5) for precipitation events less than 3 mm (i.e. a 2 mm precipitation event results in a well stage increase of approximately 74 mm) and 23 times (sd=3) for events greater than 7 mm. The large response in well stage reflects the pore volume for soil surrounding each well. The greater response for small precipitation events and the extremely rapid response time indicates most of the initial precipitation reaches ground water via stem flow, i.e. down stems and roots of plants. Subsequent and more intense precipitation tends to travel through the soil profile resulting in some retention and wetting of the surface soil layers and therefore a reduced well stage response. Similarly, Pond 20 response to precipitation was 0.5 (sd=0.3, N=4) for events less than 3 mm and 2.1 (sd=0.5, N=4) for events larger than 7 mm.

Bromide analysis was inconclusive. Concentrations observed in the wells were at or

below the limits of quantitation for the analytical method used. The study will be repeated using twice the original application rate and the analytical method used will be altered to increase the sensitivity.

Study 2. Imazapyr half-life in wetland ponds and its toxicity to Chironomid species.

Imazapyr half-life calculations indicate a half-life considerably exceeding the duration of the study. Therefore the half-life study will be repeated. No deformities were found on any Procladius which had low abundance throughout the study. Highest percentage of Chironomus mentum deformities were found in the control (50% of four individuals). Among those actually receiving imazapyr exposure, treatment deformities steadily increased as the concentration of Imazapyr increased. Average abundance of Dipteran, Chironomids, and Kiefferulus decreased as the concentration increased. Chironomus, Procladius and total individuals did not follow this trend. However, the high percentage of Chironomus deformity in the control and the divergence from expected trends in abundance could be due to the low number of samples. The experiment will be repeated with larger samples and more replications.

CONCLUSIONS

The studies reported here are inconclusive and will be repeated.

REFERENCES

- Comerford, N.B., D.G. Neary, R.S. Mansell, and H. Riekerk. 1992. Pine plantation/cypress pond wetland study. In: 1991 Annual Report: NCASI Wetlands Study, Soil and Water Science Department, Department of Forestry, Center for Wetlands, University of Florida, Gainesville Florida. pp 1-7.
- Riekerk, H., L.V. Korhnak and G. Sun. 1993. The hydrology of cypress wetlands. In: 1993 Annual Report: NCASI Wetlands Study, Soil and Water Science Department, Department of Forestry, Center for Wetlands, University of Florida, Gainesville Florida. pp 1-21.